STIC Search Report
EIC 2800

STIC Database Tracking Number: 116170

TO: Monica Lewis
Location: JEF 5A30
Art Unit : 2822
Monday, March 15, 2004

Case Serial Number: 09/981277

From: Scott Hertzog
Location: EIC 2800
JEF4B68
Phone: 272-2663

Scott.hertzog@uspto.gov

Search Notes

Examiner Lewis,

Attached are edited first pass search results from the patent and nonpatent databases.

Colored tags indicate abstracts especially worth your review.

If you need further searching or have questions or comments, please let me know.

Thanks,
Scott Hertzog

```
     FILE 'HCAPLUS, INSPEC' ENTERED AT 13:56:27 ON 15 MAR 2004
L1         9723 S SPIN(2A) VALVE# OR MTJ OR (MAGNET? OR FERROMAGNET?)(2A) TUNNEL?
L2        63078 S (SHAP#### OR TOPOG#####)(3A) SURFACE#
L3       645014 S PLANAR? OR TRUNCATE? OR MESA# OR TABLE OR
                  TABLES OR TABLETOP# OR FLAT##### OR ROUND######
L4      1304663 S PEAK# OR CRAG### OR COLUMN### OR POST# OR PINNACLE# OR CREST#### OR
                  (GRAIN? OR NANOGRAIN? OR MICROGRAIN?) (2A)(ANGLE# OR ANGULAR####)
L5        48387 S (ION OR SPUTTER?)(2A)(ETCH#### OR MILL####)
L6         6646 S (FERROMAGNET? OR FM)(2A) COUPL?
L7          836 S FLAT?(3A) PEAK?
L8          958 S L1 AND (L2 OR L3 OR L4)
L9            0 S L8 AND L7
L10          38 S L8 AND (L5 OR L6)
L11          28 DUP REM L10 (10 DUPLICATES REMOVED)
L12       12848 S SDT OR (SPIN(A) DEPEND#####)(A) TUNNEL####
                  OR TMR OR TUNNEL#####(2A)(FERROMAGNET? OR MAGNET?) OR GMR
L13        1085 S MRAM OR (FERROMAGNET? OR MAGNET########)(5A)(RAM OR RANDOM(A)ACCESS)
L14        2039 S (MAGNET? OR FERROMAGNET?)(L)(MEMORY DEVICE#)/CT
L15        1480 S (L12 OR L13 OR L14) AND (ROUGH? OR SMOOTH?
                  OR WAVE? OR WAVINESS OR WAVYNESS)
L16          85 S L15 AND (L5 OR L6)
L17          78 S L16 NOT L11
L18          54 DUP REM L17 (24 DUPLICATES REMOVED)
L19          38 S L18 NOT PY>2001
L20        1063 S L1 AND (ROUGH? OR SMOOTH? OR WAVE? OR WAVINESS OR WAVYNESS)
L21          76 S L20 AND (L5 OR L6)
L22          23 S L21 NOT L11 NOT L16
L23          17 S L22 NOT PY>2001
```

```
     FILE 'HCAPLUS' ENTERED AT 11:17:14 ON 15 MAR 2004
L1        31255 S SDT OR (SPIN(A)DEPEND#####)(A)TUNNEL####
                OR TMR OR TUNNEL#####(2A)?MAGNET? OR GMR OR ?MAGNET?(3A)RESIST?
L2         2072 S ?MAGNET?(L)(MEMORY DEVICE#)/CT
L3        16937 S (SHAP#### OR TOPOG#####)(3A)SURFACE#
L4       364366 S PLANAR? OR TRUNCATE? OR MESA# OR TABLE OR
                TABLES OR TABLETOP# OR FLAT##### OR ROUND###### FLAT? OR
                TRUNCAT?
L5      1008091 S PEAK# OR CRAG### OR COLUMN### OR POST# OR
                PINNACLE# OR CREST#### OR ?GRAIN?(2A)(ANGLE# OR ANGULAR####)
L6        26708 S (ION OR SPUTTER?)(2A)(ETCH#### OR MILL####)
L7         4085 S (FERROMAGNET? OR FM)(2A)COUPL?
L8        33094 S (L1 OR L2)
L9         2373 S L8 AND (L3 OR L4 OR L5)
L10         491 S FLAT?(3A)PEAK?
L11           1 S L9 AND L10
L12           1 S L10 AND L1
L13         392 S L1 AND (L6 OR L7)
L14           5 S L1 AND L6 AND L7
L15           5 DUP REM L14 (0 DUPLICATES REMOVED)
L16          45 S L9 AND (L6-L7)
L17          45 DUP REM L16 (0 DUPLICATES REMOVED)
L18          45 S L17
L19          23 S L17 NOT P/DT NOT PY>2001
L20           6 S L18 AND (WO OR US)/PRC(S)PRD<20011017
L21           1 S L18 NOT L20 NOT PD.B>20011017 NOT L19
L22          30 S L19-L21
```

```
     FILE 'INSPEC' ENTERED AT 11:50:45 ON 15 MAR 2004
L1          5522 S SDT OR (SPIN(A)DEPEND#####)(A)TUNNEL####
                  OR TMR OR TUNNEL#####(2A)(FERROMAGNET? OR MAGNET?) OR GMR
L2           458 S MRAM OR (FERROMAGNET? OR MAGNET########)(5A)(RAM OR RANDOM(A)ACCESS)
L3         46141 S (SHAP#### OR TOPOG#####)(3A)SURFACE#
L4        249174 S PLANAR? OR TRUNCATE? OR MESA# OR TABLE OR TABLES OR TABLETOP# OR
                   FLAT##### OR ROUND######
L5        296711 S PEAK# OR CRAG### OR COLUMN### OR POST# OR PINNACLE# OR CREST#### OR
                   (GRAIN? OR NANOGRAIN? OR MICROGRAIN?)(2A)(ANGLE# OR ANGULAR####)
L6         21679 S (ION OR SPUTTER?)(2A)(ETCH#### OR MILL####)
L7          2561 S (FERROMAGNET? OR FM)(2A)COUPL?
L8           345 S FLAT?(3A)PEAK?
L9          5809 S (L1 OR L2)
L10          635 S L9 AND (L3 OR L4 OR L5)
L11           30 S L10 AND (L6 OR L7)
L12            1 S L8 AND L9
```

L19 ANSWER 1 OF 38 HCAPLUS COPYRIGHT 2004 ACS on STN
AN 2002:303558 HCAPLUS DN 136:349548
TI Induced domain movement in **magnetic tunnel** junctions with sine-shaped small field modulations
AU Schmitz, Rolf
SO Berichte des Forschungszentrums Juelich (2001), Juel-3925, i-v, 1-124
CODEN: FJBEE5; ISSN: 0366-0885

AB First measurements on Barkhausen noise from **magnetic tunnel** junctions are presented. A low frequency magnetic field was applied to the magnetic thin film layers and then the temporary changes in the voltage signal of the junction were measured as spectral noise d. The alternating magnetic field causes a temporary change of the magnetization in the ferromagnetic layers. These changes influence the behavior of the resistance directly and the **TMR**-effect, resp. With this method it was possible to draw conclusions on the switching behavior of the magnetic domains in each magnetic layer. **Magnetic tunnel** junctions with a trilayer system made of Co/Al2O3/NiFe were fabricated. The Al2O3 barrier was fabricated using a Hg-low pressure lamp which was able to produce O radicals as well as O3 from pure O2 gas. This successful preparation method is concerned to be an alternative to the commonly used plasma oxidation All of the tunnel junctions showed a clear tunneling behavior based on the nonlinear current-voltage characteristics. The **tunneling magnetoresistance** effect of the junctions made with the UV-light were in the range of 10-20% at room temperature The magnetic switching fields were measured to 0.5 and 2 kA/m for the soft- and hard magnetic layers resp. To characterize the tunnel barrier, noise measurements at different applied magnetic fields were made. No significant changes were observed in the spectra of the UV-light oxidized and the plasma oxidized tunnel junctions. The surface **roughness** of Co and Al were also studied by x-ray diffraction and scanning force microscopy measurements. These showed clearly that a low Ar pressure during sputtering is responsible for the excellent **smoothness**. An rms-**roughness** was found which was less than 0.2 nm. **TMR** ratios of the UV-light oxidized barriers were investigated depending on the bias-voltage and temperature Furthermore, the O2 pressure was varied which was applied during the 1-h oxidation procedure of the Al. An optimal condition could be found at p = 10 mbar O2. Using this value the maximum **TMR**-ratios were received.

L19 ANSWER 12 OF 38 HCAPLUS

AN 2001:187424 HCAPLUS DN 134:260268

TI Effects of annealing on the microstructure and giant magnetoresistance (**GMR**) of Co-Cu-based spin valves

AU Mangan, M. A.; Spanos, G.; McMichael, R. D.; Chen, P. J.; Egelhoff, W. F.,Jr.

CS Naval Research Laboratory, Washington, DC, USA

SO Metallurgical and Materials Transactions A: Physical Metallurgy and Materials Science (2001), 32A(3), 577-584
CODEN: MMTAEB; ISSN: 1073-5623

PB Minerals, Metals & Materials Society

AB The effect of annealing on the microstructure and giant magnetoresistive properties of NiO/Co/Cu/Co bottom spin valves was studied by conventional and high-resolution TEM. The value of the **GMR** of these spin valves decreases from 12.2 to 2.7% after annealing in a vacuum for 30 min at 335°. This decrease is attributed to an increase in the **roughness** of the Co and Cu layers. In annealed specimens, grain boundary grooving is also observed in the antiferromagnetic NiO pinning layer at the NiO/Co interface, and the location of these grooves correlates with **waviness** in the Co/Cu interfaces. An increase in the Neel orange peel **coupling** between the **ferromagnetic** Co layers, resulting from the increased **roughness** of the Co/Cu interfaces, accompanies the degradation of the **GMR**.

L19 ANSWER 14 OF 38 HCAPLUS COPYRIGHT 2004 ACS on STN
AN 2000:231230 HCAPLUS DN 132:317108
TI Nature of coupling and origin of coercivity in giant magnetoresistance NiO-Co-Cu-based spin valves
AU Chopra, Harsh Deep; Yang, David X.; Chen, P. J.; Parks, D. C.; Egelhoff, W. F., Jr.
SO Physical Review B: Condensed Matter and Materials Physics (2000), 61(14), 9642-9652
CODEN: PRBMDO; ISSN: 0163-1829

AB The effect of various couplings on the switching field and coercivity in NiO-Co-Cu-based giant magnetoresistance (**GMR**) bottom spin valves is investigated. Bottom spin valves as well as different layer permutations that make up a bottom spin valve, viz., Co single films, Co/Cu/Co trilayers, and Co/NiO bilayers (deposited under similar growth conditions), were investigated for their magnetic, crystal, and interfacial structure. As-deposited bottom spin valves exhibit a large **GMR** of ≈16.5%, and a small net **ferromagnetic coupling** (+0.36 mT) between the "free" Co layer and the NiO-pinned Co layer. The high resolution transmission electron microscopy (HRTEM) and in situ scanning tunneling microscopy (STM) studies on spin valves and trilayers show that the average grain size in these films is ≈20 nm and average **roughness** ≈ 0.3 nm. Using these values, the observed **ferromagnetic coupling** in spin valves could largely be accounted for by Neel's so-called "orange-peel" coupling. Results also show that the "free" Co layer exhibits an enhanced coercivity (HcFree-Co=6.7 mT) with respect to Co single films of comparable thickness (HcCo=2.7 mT). The TEM studies did not reveal the presence of any pin-holes, and "orange-peel" or oscillatory exchange coupling mechanisms cannot adequately account for this observed coercivity enhancement in the "free" Co layer of spin valves. The present study shows that the often observed and undesirable coercivity enhancement in the "free" Co layer results from magnetostatic coupling between domain walls in the "free" Co layer and high coercivity NiO-pinned Co layer (HcPinned-Co≈45 mT); without NiO, the coercivity of Co layers in the corresponding Co/Cu/Co trilayer remains largely unchanged (HcCo/Cu/Co=3.0 mT) with respect to Co single films. Evidence of magnetostatically coupled domain walls was confirmed by direct observation of magnetization reversal, which revealed that domain walls in the "free" Co layer are magnetostatically locked-in with stray fields due to domain walls or magnetization ripples in the high coercivity NiO-pinned Co layer of the spin valves. The observed escape fields (defined as fields in excess of intrinsic coercivity of Co single film that are required to overcome magnetostatic coupling between domain walls) are in agreement with theor. calculated values of escape fields.

L11 ANSWER 14 OF 28 HCAPLUS DUPLICATE 7
AN 2001:249332 HCAPLUS DN 135:39902
TI Effects of oxide seed and cap layers on magnetic properties of a synthetic **spin valve**
AU Lin, Tsann; Mauri, Daniele
SO Applied Physics Letters (2001), 78(15), 2181-2183
CODEN: APPLAB; ISSN: 0003-6951

AB A synthetic **spin valve** comprising Al2O3/Ni-Cr-Fe/Ni- Fe/Pt-Mn/Co-Fe/Ru/Co-Fe/Cu/Co-Fe/Ni-Fe/Cu/Al2O3/Ta films was annealed and evaluated as a read sensor for ultrahigh-d. (≥20 Gb/in.2) recording. The Al2O3 film used as its oxide seed layer provides an in situ **flat** surface for the Pt-Mn, Co-Fe, and Ni-Fe films to develop strong {111} crystalline textures, thereby increasing its giant magnetoresistance coefficient to as high as 13.8%. Another Al2O3 film used as its oxide cap layer protects the Co-Fe/Ni-Fe sense layers from interface mixing and O interdiffusion, thus improving the soft magnetic properties and thermal stability of the sense layers. Antiferromagnetic/ **ferromagnetic coupling** between the Pt-Mn pinning and Co-Fe/Ru/Co-Fe synthetic pinned layers is strong and thermally stable enough for proper sensor operation. **Ferromagnetic/ ferromagnetic coupling** across the Cu spacer layer is antiparallel, and hence it is feasible to achieve optimal biasing of magnetoresistance responses. This synthetic **spin valve** is sandwiched into a read gap 0.1 μm in thickness, and is patterned and lapped into a read sensor 0.42 and 0.23 μm in phys. width and height, resp. With a sense current of 4 mA, this read sensor exhibits an effective read width of 0.31 μm, stable magnetoresistance responses, and signal sensitivity of 6.64 mV/μm.

IT Coercive force (magnetic)
Ferromagnetic exchange
Giant magnetoresistance
Magnetic moment
Magnetoresistance
Spin valves
(effects of oxide seed and cap layers on magnetic properties of synthetic **spin valve** comprising Al2O3/Ni-Cr-Fe/Ni-Fe/Pt-Mn/Co-Fe/Ru/Co-Fe/Cu/Co-Fe/Ni-Fe/Cu/Al2O3/Ta films)

IT 1344-28-1, Alumina, properties 7440-18-8, Ruthenium, properties
7440-25-7, Tantalum, properties 7440-50-8, Copper, properties
11148-32-6 12649-48-8 12781-95-2 77088-24-5
RL: DEV (Device component use); PEP (Physical, engineering or chemical process); PRP (Properties); PROC (Process); USES (Uses)
(effects of oxide seed and cap layers on magnetic properties of synthetic **spin valve** comprising Al2O3/Ni-Cr-Fe/Ni-Fe/Pt-Mn/Co-Fe/Ru/Co-Fe/Cu/Co-Fe/Ni-Fe/Cu/Al2O3/Ta films)

L11 ANSWER 18 OF 28 HCAPLUS COPYRIGHT 2004 ACS on STN DUPLICATE 9
AN 1999:263545 HCAPLUS Full-text
TI Effect of finite magnetic film thickness on Neel coupling in **spin valves**
AU Kools, J. C. S.; Kula, W.; Mauri, Daniele; Lin, Tsann
SO Journal of Applied Physics (1999), 85(8, Pt. 2A), 4466-4468
CODEN: JAPIAU; ISSN: 0021-8979
AB **Spin valves** are widely studied due to their application as magnetoresistive material in magnetic recording heads and other magnetic field sensors. An important film property is the interlayer coupling field (called offset field Ho or **ferromagnetic coupling** field Hf). It has been shown that the Neel model for orange-peel coupling can be applied successfully to describe this interlayer coupling. The waviness associated with the developing granular structure is thereby taken as the relevant waviness. The original Neel model describes the ferromagnetic magnetostatic interaction between two ferromagnetic layers, of infinite thickness, separated by a nonmagnetic spacer with a correlated interface waviness. In this article, this phys. picture is refined to account for the effect of the finite thickness of the magnetic films in a **spin valve.** Magnetic poles created at the outer surfaces of the magnetic layers result in an antiferromagnetic interaction with the poles at the inner surface of the opposite layer. A simple model is presented for the different interactions in a top **spin valve** (**columnar** structure with cumulative waviness on a **flat** substrate) and for a bottom **spin valve** (**columnar** structure with conformal waviness on a way substrate). Comparison to exptl. data, shows that the free and pinned layer thickness dependence can be understood from this refined picture.

L11 ANSWER 26 OF 28 INSPEC (C) 2004 IEE on STN
AN 1995:4942890 INSPEC DN A9511-6865-009 Full-text
TI Effect of energetic particle bombardment during sputter deposition on the properties of exchange-biased **spin-valve** multilayers.
AU Kools, J.C.S. (Philips Res. Lab., Eindhoven, Netherlands)
SO Journal of Applied Physics (1 April 1995) vol.77, no.7, p.2993-8. 18 refs.
Price: CCCC 0021-8979/95/77(7)/2993/6/$6.00
CODEN: JAPIAU ISSN: 0021-8979

AB The effect of energetic particle bombardment during sputter deposition on the physical (magnetoresistance and interlayer coupling) and microstructural (roughness and interface thickness) properties of exchange-biased **spin-valve** multilayers is investigated. An increasing pressure leads, through enhanced stopping of energetic particles by collisions with the background gas, to a decrease of the interfacial intermixing by collisions during growth, and to a more rough, void-rich structure. These microstructural changes lead to an increase of the transmissivity of the interfaces for conduction electrons, as well as to an increase of the **ferromagnetic** interlayer **coupling** with increasing pressure.

CT CHEMICAL INTERDIFFUSION; ENERGY LOSS OF PARTICLES; EXCHANGE INTERACTIONS (ELECTRON); FERROMAGNETISM; GIANT MAGNETORESISTANCE; INTERFACE STRUCTURE; ION BEAM MIXING; MAGNETIC MULTILAYERS; METALLIC SUPERLATTICES; PERMALLOY; SPUTTER DEPOSITION; SURFACE DIFFUSION; **SURFACE TOPOGRAPHY**; VOIDS (SOLID)

ST sputter deposition; energetic particle bombardment; **exchange-biased spin-valve multilayers**; magnetoresistance; roughness; interface thickness; interfacial intermixing; void-rich structure; transmissivity; **ferromagnetic interlayer coupling**; Ni80Fe20; GMR effect

L11 ANSWER 27 OF 28 INSPEC (C) 2004 IEE on STN

AN 1996:5205731 INSPEC DN A9607-7570-041; B9604-3110M-008 Full-text

TI STM studies of GMR **spin valves**.

AU Misra, R.D.K.; Ha, T.; Kadmon, Y.; Powell, C.J.; Stiles, M.D.; McMichael, R.D.; Egelhoff, W.F., Jr. (Nat. Inst. of Stand. & Technol., Gaithersburg, MD, USA)

SO Magnetic Ultrathin Films, Multilayers and Surfaces. Symposium
Editor(s): Marinero, E.E.; Heinrich, B.; Egelhoff, W.F., Jr.; Fert, A.; Fujimori, H.; Guntherodt, G.; White, R.L.
Pittsburgh, PA, USA: Mater. Res. Soc, 1995. p.373-83 of xii+553 pp.

AB We have investigated the surface roughness and the grain size in giant magnetoresistance (GMR)**spin valve** multilayers of the general type: FeMn/Ni80Fe20/Co/Cu/Co/Ni80Fe20 on glass and aluminium oxide substrates by scanning tunneling microscopy (STM). The two substrates give very similar results. These polycrystalline GMR multilayers have a tendency to exhibit larger grain size and increased roughness with increasing thickness of the metal layers. Samples deposited at a low substrate temperature (150 K) exhibit smaller grains and less roughness. Valleys between the dome-shaped individual grains are the dominant form of roughness. This roughness contributes to the **ferromagnetic,** magnetostatic **coupling** in these films, an effect termed 'orange peel' coupling by Neel. We have calculated the strength of this coupling, based on our STM images, and obtain values generally within about 20% of the experimental values. It appears likely that the **ferromagnetic coupling** generally attributed to so-called 'pinholes' in the Cu when the Cu film thickness is too small is actually 'orange peel' coupling caused by these valleys.

CT COBALT; COPPER; FERROMAGNETIC MATERIALS; GIANT MAGNETORESISTANCE; GRAIN SIZE; IRON ALLOYS; MAGNETIC MULTILAYERS; MAGNETIC PARTICLES; MAGNETOSTATIC WAVES; MANGANESE ALLOYS; METALLIC SUPERLATTICES; NICKEL ALLOYS; SCANNING TUNNELLING MICROSCOPY; **SURFACE TOPOGRAPHY**

ST orange peel coupling; surface roughness; grain size; giant magnetoresistance; **spin valve multilayers**; scanning tunneling microscopy; substrate temperature; magnetostatic coupling; **ferromagnetic coupling**; film thickness; 150 K; FeMn-Ni80Fe20-Co-Cu-Co-Ni80Fe20

L19 ANSWER 5 OF 38 HCAPLUS COPYRIGHT 2004 ACS on STN
AN 2001:589460 HCAPLUS Full-text
DN 135:297356
TI Structural and magnetoresistive properties of Co/Cu multilayers
AU Marszalek, M.; Jaworski, J.; Michalik, A.; Prokop, J.; Stachura, Z.; Voznyi, V.; Bolling, O.; Sulkio-Cleff, B.
CS H. Niewodniczanski Institute of Nuclear Physics, Krakow, 31-342, Pol.
SO Journal of Magnetism and Magnetic Materials (2001), 226-230(Pt. 2), 1735-1737
CODEN: JMMMDC; ISSN: 0304-8853
PB Elsevier Science B.V.
AB Co/Cu multilayers (ML) were thermally evaporated at very low deposition rates on Si substrates covered with buffer layers of different metals (Ag, Cu, In, Pb, Bi). Structural characterization of samples was performed by x-ray reflectometry (XRR), XRD and atomic force microscopy (AFM). Magnetoresistance measurements were carried out at room temperature using a standard 4-probe d.c. method with current in the plane of the sample. It seems that a choice of buffer type has no significant effect on the magnitude of **GMR**. Since the thickness of single layers is of similar magnitude as the interfacial **roughness** in samples the authors suggest that the observed small value of **GMR** effect can be attributed rather to the interruption of film continuity and creation of magnetic bridges between Co layers, resulting in direct **ferromagnetic coupling** of magnetic films.
CC 77-1 (Magnetic Phenomena)
IT Evaporation
Ferromagnetic exchange
Giant magnetoresistance
Grain size
Interface **roughness**
Magnetic films
Magnetic multilayers
Magnetoresistance
Order
(structural and magnetoresistive properties of Co/Cu multilayers)

L19 ANSWER 6 OF 38 HCAPLUS COPYRIGHT 2004 ACS on STN
AN 2001:502087 HCAPLUS DN 135:265908
TI Magnetoresistance and magnetic properties of magnetic thin film multilayers
AU Neamtu, J.; Volmer, M.
SO Surface Science (2001), 482-485(Pt. 2), 1010-1014
CODEN: SUSCAS; ISSN: 0039-6028
AB The magnetic properties and the magnetoresistance in correlation with microstructural properties of permalloy monolayer and [NiFe(t)/Cu(s)/NiFe(t)]n or [NiFe(t)/Mo(s)/NiFe(t)] multilayers have been studied. The thickness (t) of NiFe layers was ranged from 4-12 nm, while the Cu and Mo layers (s) were ranged from 3-8 nm. The multilayers exhibit magnetoresistive properties different from those of permalloy film. By decreasing of the NiFe layer thickness and increasing of the nonmagnetic interlayer thickness, the influence of interfacial intermixing effects on magnetic properties become more important. The magnetic properties of [NiFe/Mo/NiFe] trilayer show a weak **ferromagnetic coupling** like those presented by the multilayers with a relatively thick nonmagnetic interlayer (5-8 nm). Although the thickness of layers has the leading part for magnitude of **GMR** effect, the microstructural properties of interfaces and the grain boundaries scattering must not be neglected.
IT Giant magnetoresistance
Surface **roughness**
(magnetoresistance and magnetic properties of magnetic thin film multilayers)

L19 ANSWER 18 OF 38 HCAPLUS COPYRIGHT 2004 ACS on STN

AN 1997:779027 HCAPLUS DN 128:109012

TI Oxygen as a surfactant in the growth of giant magnetoresistance spin valves

AU Egelhoff, W. F., Jr.; Chen, P. J.; Powell, C. J.; Stiles, M. D.; McMichael, R. D.; Judy, J. H.; Takano, K.; Berkowitz, A. E.

SO Journal of Applied Physics (1997), 82(12), 6142-6151
CODEN: JAPIAU; ISSN: 0021-8979

PB American Institute of Physics

AB The authors found a novel method for increasing the giant magnetoresistance (**GMR**) of Co/Cu spin valves using O. Surprisingly, spin valves with the largest **GMR** are not produced in the best vacuum. Introducing 5+10-9 Torr (7+10-7 Pa) into the authors' ultrahigh vacuum deposition chamber during spin-valve growth increases the **GMR**, decreases the **ferromagnetic coupling** between magnetic layers, and decreases the sheet resistance of the spin valves. Apparently the O may act as a surfactant during film growth to suppress defects and to create a surface which scatters electrons more specularly. Using this technique, bottom spin valves and sym. spin valves with **GMR** values of 19.0 and 24.8, resp., were produced. These are the largest values ever reported for such structures.

IT Crystal defects
Ferromagnetic exchange
Giant magnetoresistance
Interface **roughness**
Sheet resistance
Sputtering
Surfactants
(oxygen as surfactant in growth of cobalt/copper spin valves with giant magnetoresistance)

L19 ANSWER 21 OF 38 HCAPLUS

AN 1996:592293 HCAPLUS DN 125:236548

TI Quenching of giant magnetoresistance by interface **roughening** and alloying in annealed [(NixFe1-x)yAu1-y]/Au multilayers

AU Farrow, R. F. C.; Parkin, S. S. P.; Marks, R. F.; Krishnan, Kannan M.; Thangaraj, N.

SO Applied Physics Letters (1996), 69(13), 1963-1965
CODEN: APPLAB; ISSN: 0003-6951

AB Antiferromagnetically coupled permalloy/Au multilayers display giant magnetoresistance (**GMR**) with large changes in resistance in very low fields. Thermal annealing of such structures, exhibiting **GMR** , leads to a quenching of the magnetoresistance. The detailed structure of the permalloy/Au interfaces was probed using high-resolution cross-section TEM. On annealing, the Au layers interdiffuse into the permalloy layers, which leads both to **rougher** permalloy/Au interfaces and to thinner Au spacer layers. The authors infer that the latter results in **ferromagnetic coupling** of the permalloy layers, which accounts for the reduced **GMR**.

L19 ANSWER 23 OF 38 HCAPLUS

AN 1996:282201 HCAPLUS DN 125:24577

TI In situ scanning tunneling microscopy observation of surface evolution in magnetically coupled Co/Cu multilayers

AU Minvielle, Timothy J.; Wilson, Robert J.; White, Robert L.

SO Applied Physics Letters (1996), 68(19), 2750-2752
CODEN: APPLAB; ISSN: 0003-6951

AB Bilayers Cu(100)/[Co(21 Å)/Cu(21 Å)]n were grown by both ion beam and d.c. magnetron sputtering techniques. Scanning tunneling microscopy images of the developing layers demonstrate a marked difference in the way in which **roughness** evolves through the films. The higher energy ion beam sputtered systems show a nonconformal **roughness** that was characterized by comparatively large lateral length scales. The less energetic magnetron-formed systems exhibit an island-upon-island growth that is conformal from layer to layer. Kerr effect measurements show that the former is **ferromagnetically coupled** and the latter is antiferromagnetically coupled. An explanation is presented that attributes the differences in **roughness** to the potential barriers at step edges. Adatom mobility and incident energy are the determining factor for this kind of conformal growth.

L19 ANSWER 26 OF 38 HCAPLUS
AN 1995:946644 HCAPLUS DN 124:18949
TI STM studies of **GMR** spin valves
AU Misra, R. D. K.; Ha, T.; Kadmon, Y.; Powell, C. J.; Stiles, M. D.; McMichael, R. D.; Egelhoff, W. F., Jr.
SO Materials Research Society Symposium Proceedings (1995), 384(Magnetic Ultrathin Films Multilayers and Surfaces), 373-83
CODEN: MRSPDH; ISSN: 0272-9172
AB The authors have studied the surface **roughness** and the grain size in giant magnetoresistance (**GMR**) spin valve multilayers of the general type: FeMn/Ni80Fe20/Co/Cu/Co/Ni80Fe20 on glass and Al oxide substrates by scanning tunneling microscopy (STM). The 2 substrates give very similar results. These polycryst. **GMR** multilayers have a tendency to exhibit larger grain size and increased **roughness** with increasing thickness of the metal layers. Samples deposited at a low substrate temperature (150 K) exhibit smaller grains and less **roughness** . Valleys between the dome-shaped individual grains are the dominant form of **roughness**. This **roughness** contributes to the **ferromagnetic,** magnetostatic **coupling** in these films, an effect termed orange peel coupling by Neel. The authors have calculated the strength of this coupling, based on the STM images, and obtain values generally within .apprx.20% of the exptl. values. It appears likely that the **ferromagnetic coupling** generally attributed to so-called pinholes in the Cu when the Cu film thickness is too small is actually orange peel coupling caused by these valleys.
IT Surface structure
(**roughness,** STM studies of giant magnetoresistance FeMn/Ni80Fe20/Co/Cu/Co/Ni80Fe20 spin valves on glass and Al oxide substrates)

L19 ANSWER 34 OF 38 INSPEC (C) 2004 IEE on STN
AN 2001:6961257 INSPEC DN A2001-15-7570C-032; B2001-08-3110M-018
TI Reduction of interlayer coupling in bottom synthetic spin valves through a gas exposure process.
AU Makino, E.; Ishii, S.; Syoji, M.; Furukawa, A.; Hosomi, M.; Matuzono, A.
SO Journal of Applied Physics (1 June 2001) vol.89, no.11, pt.1-2, p.7619-21.8 refs.
Doc. No.: S0021-8979(01)26611-0
CODEN: JAPIAU ISSN: 0021-8979
Conference: Eighth Joint Magnetism and Magnetic Materials Intermag Conference. San Antonio, TX, USA, 7-11 Jan 2001
AB The magnetoresistance (MR) ratio of spin valves can be improved by reducing the thickness of the nonmagnetic interlayer, such as Cu, due to not only reducing the shunt, but also increasing the probability of electrons scattered through the Cu. However, at small thickness, interlayer coupling between the free and pinned layer is increased, which makes it difficult to control the bias point. The minimum thickness of the interlayer Cu was thereby limited to around 3 nm. On the other hand, it is reported that the **ferromagnetic** interlayer **coupling** that arises from the film **roughness** can be reduced by controlling the residual gas inside the deposition chamber. The same effect can also be achieved by exposing the wafer into an oxygen gas atmosphere right after the deposition of the high conductive Cu interlayer. By this method the thickness of the interlayer Cu was reduced successfully from 3.0 to 2.0 nm without increasing the interlayer coupling. As a result, the MR ratio and dRsq was improved by 12% and 48%, and showed 10% and 1.82 Omega , respectively. Furthermore, by inserting a Cu backlayer to form a spin filter spin valve structure an antiferromagnetic interlayer coupling was also observed.
ST interlayer coupling reduction; bottom synthetic spin valves; gas exposure process; magnetoresistance ratio; nonmagnetic interlayer thickness reduction; bias point; minimum thickness; ferromagnetic interlayer; antiferromagnetic interlayer; giant magnetoresistance; **GMR**; Cu

L23 ANSWER 3 OF 17 HCAPLUS

AN 2001:245377 HCAPLUS DN 135:13402

TI Studies on interfacial and crystalline structures of **spin-valve** multilayers

AU Lu, Zhengqi; Wang, Wendong; Chai, Chunlin; Lai, Wuyan; Zheng, Yuankai

SO IEEE Transactions on Magnetics (2000), 36(5, Pt. 1), 2869-2871
CODEN: IEMGAQ; ISSN: 0018-9464

AB **Spin valves** of high quality were fabricated by a two-step deposition procedure. Lower sublayers (i.e., buffer layer Ta/free layer NiFe/interlayer Cu) are deposited at a lower argon pressure, which promotes the formation of strong (111) textures, **smooth** interfaces, and dense Cu film, and upper sublayers (i.e., pinned layer NiFe/pinning layer FeMn/cover Ta) are deposited at a higher pressure, which promotes small grains and less diffusive interface. The independent control of the magnetoresistance, the **ferromagnetic** interlayer **coupling**, and exchange biasing is achieved by improving the interfacial and crystalline structures of the **spin valves**.

L23 ANSWER 4 OF 17 HCAPLUS COPYRIGHT 2004 ACS on STN
AN 2000:561582 HCAPLUS DN 133:259789
TI Magnetoresistance enhancement in specular, bottom-pinned, Mn83Ir17 **spin valves** with nano-oxide layers
AU Veloso, A.; Freitas, P. P.; Wei, P.; Barradas, N. P.; Soares, J. C.; Almeida, B.; Sousa, J. B.
SO Applied Physics Letters (2000), 77(7), 1020-1022
CODEN: APPLAB; ISSN: 0003-6951
AB Bottom-pinned Mn83Ir17 **spin valves** with enhanced specular scattering were fabricated, showing magnetoresistance (MR) values up to 13.6%, lower sheet resistance R.box. and higher ΔR.box.. Two nano-oxide layers (NOL) are grown on both sides of the CoFe/Cu/CoFe **spin valve** structure by natural oxidation or remote plasma oxidation of the starting CoFe layer. Maximum MR enhancement is obtained after just 1 min plasma oxidation RBS anal. shows that a 15 ± 2 Å oxide layer grows at the expense of the initial (prior to oxidation) CoFe layer, with .apprx.12% reduction of the initial 40-Å CoFe thickness. X-ray reflectometry indicates that Kiessig fringes become better defined after NOL growth, indicating **smoother** inner interfaces, in agreement with the observed decrease of the **spin-valve ferromagnetic** Neel **coupling**.

L23 ANSWER 14 OF 17 INSPEC (C) 2004 IEE on STN
AN 1999:6235660 INSPEC DN A1999-11-7570C-008; B1999-06-3110M-003
TI Effect of finite magnetic film thickness on Neel coupling in **spin valves**.
AU Kools, J.C.S.; Kula, W. (CVC, Fremont, CA, USA); Mauri, D.; Lin, T.
SO Journal of Applied Physics (15 April 1999) vol.85, no.8, p.4466-8. 16 Refs.
Doc. No.: S0021-8979(99)18808-X
CODEN: JAPIAU ISSN: 0021-8979
Conference: 43rd Annual Conference on Magnetism and Magnetic Materials. Miami, FL, USA, 9-12 Nov 1998
AB **Spin valves** are widely studied due to their application as magnetoresistive material in magnetic recording heads and other magnetic field sensors. An important film property is the interlayer coupling field (called offset field Ho or **ferromagnetic coupling** field Hf). It has been shown that the Neel model for orange-peel coupling can be applied successfully to describe this interlayer coupling. The **waviness** associated with the developing granular structure is thereby taken as the relevant **waviness**. The original Neel model describes the ferromagnetic magnetostatic interaction between two ferromagnetic layers, of infinite thickness, separated by a nonmagnetic spacer with a correlated interface **waviness**. In this article, this physical picture is refined to account for the effect of the finite thickness of the magnetic films in a **spin valve**. Magnetic poles created at the outer surfaces of the magnetic layers result in an antiferromagnetic interaction with the poles at the inner surface of the opposite layer. A simple model is presented for the different interactions in a top **spin valve** (columnar structure with cumulative **waviness** on a flat substrate) and for a bottom **spin valve** (columnar structure with conformal **waviness** on a way substrate). Comparison to experimental data, shows that the free and pinned layer thickness dependence can be understood from this refined picture.
ST **correlated interface waviness**; magnetic films; magnetic poles;

L15 ANSWER 2 OF 5 HCAPLUS COPYRIGHT 2004 ACS on STN
AN 1998:696816 HCAPLUS DN 130:9547
TI Manufacture of magnetoresistance-effect multilayer films
IN Noguchi, Noboru
PA Hitachi Metals, Ltd., Japan
IC ICM G11B005-39
ICS H01F041-18; H01L043-12

	PATENT NO.	KIND	DATE	APPLICATION NO.	DATE
PI	JP 10289421	A2	19981027	JP 1997-98609	19970416

AB The title manufacture of spin valve films with Mn-Ni alloy antiferromagnetic materials by **ferromagnetic**/antiferromagnetic exchange- **coupled** magnetic field involves forming a Mn-Ni alloy antiferromagnetic layer on a substrate, depositing a ferromagnetic layer, annealing the laminate film under a magnetic field in a desired orientation to provide a exchange-coupled magnetic field, **ion- milling** to remove a portion of the ferromagnetic layer not to expose the antiferromagnetic layer, forming a pinning layer, depositing a non-magnetic layer, and subsequently forming an exchange field-free ferromagnetic layer. The manufacturing process provides the corrosion-resistant and thermal-resistant spin valve films without characteristic deterioration during annealing in the magnetic field. The products provides high-quality MR heads with decreased noise and hysteresis.

L22 ANSWER 25 OF 30 HCAPLUS COPYRIGHT 2004 ACS on STN
AN 1983:45704 HCAPLUS
TI Sloping insulative layer in bubble memory
IN Silverman, Peter J.
PA Intel Magnetics, Inc., USA

	PATENT NO.	KIND	DATE	APPLICATION NO.	DATE
PI	US 4358356	A	19821109	US 1981-252798	19810413 <--

PRAI US 1981-252798 19810413 <--

AB A method for removing rounded regions in SiO_2 layers covering Permalloy conductors consists of **ion milling** the layer at an angle of incidence of 0° with respect to the **planar** surface and 45° with respect to the rounded region.

IC C23F001-02

NCL 204192000E

IT **Memory devices**
(**magnetic**, bubble-domain, **ion** beam **milling** of silica rounded layers in)

L11 ANSWER 7 OF 30 INSPEC (C) 2004 IEE on STN
AN 2002:7394118 INSPEC DN A2002-21-6820-035; B2002-11-2550E-025 Full-text
TI Smoothing thin films with gas-cluster ion beams.
AU Fenner, D.B.; Hautala, J.; Allen, L.P.; Greer, J.A.; Skinner, W.J.); Budnick,J.I.
SO Magnetic Materials, Structures and Processing for Information Storage. Symposium (Materials Research Society Symposium Proceedings Vol.614) Editor(s): Daniels, B.J.; Nolan, T.P.; Seigler, M.A.; Wang, S.X.; Murray, C.B. Warrendale, PA, USA: Mater. Res. Soc, 2001. p.F10.3.1-6 of xi+178 pp. 18 refs. Conference: San Francisco, CA, USA, 24-27 April 2000
ISBN: 1-55899-522-6

AB Thin-film magnetic sensor and memory devices in future generations may benefit from a processing tool for final-step etching and smoothing of surfaces to nearly an atomic scale. Gas-cluster ion-beam (GCIB) systems make possible improved surface sputtering and processing for many types of materials. We propose application of GCIB processing as a key smoothing step in thin-film magnetic-materials technology, especially spin-valve **GMR**. Results of argon GCIB etching and smoothing of surfaces of alumina, silicon, permalloy and tantalum films are reported. No accumulating roughness or damage is observed. The distinct scratches and tracks seen in atomic-force microscopy of CMP-processed surfaces, are removed almost entirely by subsequent GCIB processing. The technique primarily reduces high spatial-frequency roughness and renders the topographic surface elevations more nearly gaussian (randomly distributed).

CT ALUMINA; ARGON; ATOMIC FORCE MICROSCOPY; ELEMENTAL SEMICONDUCTORS; GIANT MAGNETORESISTANCE; ION BEAMS; MAGNETIC THIN FILMS; PERMALLOY; ROUGH SURFACES; SILICON; SPIN VALVES; **SPUTTER ETCHING**; **SURFACE TOPOGRAPHY**; TANTALUM

ST Al2O3 thin film; Si thin film; permalloy thin film; tantalum thin film; thin film smoothing; gas cluster ion beams; GCIB; magnetic sensor; magnetic memory device; etching; magnetic materials; **spin valve GMR**; argon; atomic force microscopy; CMP; surface roughness; surface topographic elevations; Gaussian distribution; Al2O3; Ta; Si; NiFe; Ar

L11 ANSWER 9 OF 30 INSPEC (C) 2004 IEE on STN
AN 2002:7291390 INSPEC DN A2002-14-7570P-032; B2002-07-3110M-016 Full-text
TI Fabrication and magnetoresistance properties of **spin-dependent tunnel** junctions using an epitaxial Fe3O4 film.

FYI

AU Matsuda, H.; Takeuchi, M.; Adach, H.; Hiramoto, M.; Matsukawa, N.; Odagawa, A.; Setsune, K.; Sakakima, H.
SO Japanese Journal of Applied Physics, Part 2 (Letters) (1 April 2002) *
vol.41, no.4A, p.L387-90. 16 refs.
Published by: Japan Soc. Appl. Phys
CODEN: JAPLD8 ISSN: 0021-4922
AB Magnetoresistance of **spin-dependent tunnel** junctions has been studied using a high-quality epitaxial Fe3O4 film. The bottom magnetic electrodes of epitaxial Fe3O4 were grown onto the TiN-buffered (110) surface of MgO single-crystal substrates, and trilayer junctions of Fe3O4/AlOx/CoFe **mesa** were fabricated by sequential sputtering and Ar **ion etching**. The junctions showed the magnetoresistance (MR) ratio of more than 10% at room temperature with butterfly-like hysteresis which arose from the different coercive fields between Fe3O4 and CoFe when the field was applied along the easy axis of the epitaxial Fe3O4 layer. The MR ratio remained almost constant against the temperature down to nearly 100 K. Below 100 K, the decrease of MR and the increase of junction resistance were observed, which may be related to the Verwey transition that inevitably occurs in the characteristic of high-quality Fe3O4 samples.
ST magnetoresistance; **spin-dependent tunnel junctions**; MR ratio; epitaxial Fe3O4 film; TiN-buffered MgO(110) surface; trilayer junctions; **Fe3O4/AlOx/CoFe mesa**; sequential sputtering; **Ar ion etching**; coercive fields; temperature effects; junction resistance; Verwey transition; 300 K; 100 K; Fe3O4-TiN-MgO; MgO; Fe3O4-AlO-CoFe; Ar

L11 ANSWER 11 OF 30 INSPEC (C) 2004 IEE on STN

AN 2002:7148674 INSPEC DN A2002-04-6865-021 Full-text

TI Microstructure of Co/Cu multilayers studied by low-angle X-ray diffraction and scanning force microscopy.

AU Marszalek, M.; Jaworski, J. im. H. Niewodniczanskiego, Krakow, Poland); Marszalek, K.; Bolling, O.; Sulkio-Cleff, B.

SO Elektronika (2001) vol.42, no.8-9, p.81-3. 5 refs. Published by: SIGMA NOT CODEN: EKNTBZ ISSN: 0033-2089

AB In this paper we present the studies of the microstructure of Co/Cu multilayers (ML) at the second antiferromagnetic maximum of exchange coupling and the influence of microstructure on the giant magnetoresistivity. Co/Cu multilayers were thermally evaporated on Si substrates covered with buffer layers of different metals known as surfactants (Ag, Cu, In, Pb, Bi). Surfactant properties lead in epitaxial growth to the layer-by-layer growth in conditions when usually 3D growth is observed. Structural characterisation of samples performed by low-angle X-ray diffraction resulted in determining of the structure and the interface roughness of the studied systems. The **topography** of the **surface** of ML and of the buffer layers has been measured with scanning force microscopy (SFM). Magnetoresistance measurements were carried out at room temperature using a standard four-probe DC method with current in the plane of the sample. It seems that a choice of buffer type have no significant effect on the magnitude of **GMR**. The influence of the roughness on the giant magnetoresistivity is negligible. However, the correlation between **GMR** and the size of islands on the sample surface has need observed. We suggest that the observed effect can be attributed to the interruption of film continuity and the formation of magnetic bridges between Co layers, resulting in direct **ferromagnetic coupling** of magnetic films. The creation of granular entities due to the enhanced interlayer diffusion caused by the presence of surfactant metals is the most likely source of **GMR** in studied samples.

ST microstructure; multilayers; low-angle X-ray diffraction; scanning force microscopy; SFM; second antiferromagnetic maximum; exchange coupling; giant magnetoresistivity; epitaxial growth; layer-by-layer growth; room temperature; **GMR**; enhanced interlayer diffusion; 293 K; Si; Co-Cu

L11 ANSWER 19 OF 30 INSPEC (C) 2004 FIZ KARLSRUHE on STN
AN 1999:6334993 INSPEC DN A1999-19-7570C-048; B1999-10-3110M-004 Full-text
TI Properties of spin-valve structures deposited on step-bunched vicinal surfaces.
AU Encinas, A.; Nguyen Van Dau, F.; Schuhl, A.; Montaigne, F.; Sussiau, M.; Galtier, P. (Thomson-CSF, Orsay, France)
SO Journal of Magnetism and Magnetic Materials (June 1999) vol.198-199, p.15-17.
Doc. No.: S0304-8853(98)00595-2
CODEN: JMMMDC ISSN: 0304-8853
Conference: Third International Symposium on Metallic Multilayers (MML'98). Vancouver, BC, Canada, 14-19 June 1998
AB We have investigated the properties of Co/Cu/FeNi spin-valve structures deposited on step-bunched vicinal Si(111) substrates. We first discuss the in-plane uniaxial magnetic anisotropy induced in each magnetic layer by the initial surface corrugation. A **ferromagnetic coupling** of the two magnetizations is found, which is analyzed as a function of the spacer-layer thickness. Giant magnetoresistance (**GMR**) of the spin-valve structures is then investigated as a function of the in-plane current direction. Because of the initial corrugation, we observe current perpendicular to the plane (CPP) contributions to the **GMR** of the spin-valve structures. These CPP contributions can lead to an increase of the absolute **GMR** by up to 70% at room temperature, when the current is applied perpendicular to the steps direction.
CT COBALT; GIANT MAGNETORESISTANCE; INDUCED ANISOTROPY (MAGNETIC); IRON ALLOYS; MAGNETIC MULTILAYERS; NICKEL; NICKEL ALLOYS; SPIN VALVES; **SURFACE TOPOGRAPHY**
ST spin-valve structures; step-bunched vicinal surfaces; Si(111) substrate; uniaxial magnetic anisotropy; magnetic multilayer; surface corrugation; **ferromagnetic coupling**; magnetization; spacer-layer thickness dependence; giant magnetoresistance; plane-perpendicular current; interlayer coupling; 30 to 200 angstrom; Co-Cu-FeNi; Si

L11 ANSWER 25 OF 30 INSPEC (C) 2004 IEE on STN
AN 1997:5712419 INSPEC DN A9722-7570-016; B9711-3110M-030 Full-text
TI In situ and ex situ observation of spin valves obtained by ion-beam deposition.
AU Guarisco, D.; Kay, E.; Wang, S.X.
SO IEEE Transactions on Magnetics (Sept. 1997) vol.33, no.5, pt.2, p.3595-7.
11 refs. Published by: IEEE
CODEN: IEMGAQ ISSN: 0018-9464
Conference: 1997 IEEE International Magnetics Conference (INTERMAG '97). New Orleans, LA, USA, 1-4 April 1997
AB "Bottom" spin valves of the type NiO/15 AA NiFe/15 AA Co/tCu Cu/20 AA Co/50 AA NiFe were prepared by ion-beam deposition (IBD) on a Si(100)/NiO substrate. It is found that cleaning the substrates by **ion**-beam **etching** prior to the deposition of the multilayer has a significant influence on the magnetic properties of the spin valve. In particular, longer etching leads to a decrease in the exchange field and an increase in the coercivity of the pinned layer, without affecting the **GMR** ratio. A maximum **GMR** of 11.2% at room temperature is obtained for tCu=20 AA and 240 s etching time. The NiO substrate before and after **ion**-beam **etching** has been studied by atomic force microscopy (AFM). No significant change in roughness is observed, but the etched substrate shows smaller features.
CT ANTIFERROMAGNETIC MATERIALS; ATOMIC FORCE MICROSCOPY; COBALT; COERCIVE FORCE; COPPER; EXCHANGE INTERACTIONS (ELECTRON); FERROMAGNETIC MATERIALS; GIANT MAGNETORESISTANCE; INTERFACE STRUCTURE; IRON ALLOYS; MAGNETIC MULTILAYERS; NICKEL ALLOYS; NICKEL COMPOUNDS; SOFT MAGNETIC MATERIALS; SPUTTER DEPOSITION; **SPUTTER ETCHING**; SURFACE CLEANING; **SURFACE TOPOGRAPHY**
ST in situ observation; ex situ observation; spin valves; ion-beam deposition; NiO/NiFe/Co/Cu/Co/NiFe; bottom spin valves; Si(100)/NiO substrate; cleaning; **ion-beam etching**; magnetic properties; exchange field; coercivity; pinned layer; **GMR ratio**; room temperature; etching time; NiO substrate; atomic force microscopy; AFM; roughness; etched substrate; 15 A; 20 A; 50 A; 20 C; 240 s; NiO-NiFe-Co-Cu-Co-NiFe

L11 ANSWER 26 OF 30 INSPEC (C) 2004 IEE on STN
AN 1996:5408751 INSPEC DN A9623-7570-032; B9612-3110M-009 Full-text
TI Interlayer coupling and surface roughness in **GMR** spin valves.
AU Wei, D.; Bertram, H.N. (Center for Magnetic Recording Res., California Univ., San Diego, La Jolla, CA, USA)
SO IEEE Transactions on Magnetics (Sept. 1996) vol.32, no.5, pt.1, p.3434-6.8 refs.
Published by: IEEE
CODEN: IEMGAQ ISSN: 0018-9464
Conference: 1996 IEEE International Magnetics Conference (INTERMAG '96).
AB An atomic-scale model is developed to analyze interlayer coupling in permalloy/silver/permalloy **GMR** spin valves. The coupling in a smooth interface spin valve is assumed to be anti-ferromagnetic due to interlayer electron scattering. With rough silver/permalloy interfaces, the **coupling** remains anti-**ferromagnetic** even with the enhanced magnetostatic energy.
CT GIANT MAGNETORESISTANCE; MAGNETIC MULTILAYERS; PERMALLOY; SILVER; **SURFACE TOPOGRAPHY**
ST interlayer coupling; surface roughness; atomic-scale model; **permalloy/silver/permalloy GMR spin valve**; antiferromagnetic coupling; electron scattering; magnetostatic energy; NiFe-Ag-NiFe

L11 ANSWER 12 OF 30 INSPEC (C) 2004 IEE on STN
AN 2001:6961335 INSPEC DN B2001-08-3120B-006 Full-text
TI **Magnetic tunnel** junctions on **magnetic** shield
smoothed by gas cluster ion beam.
AU Sun, J.J.; Shimazawa, K.; Kasahara, N.; Sato, K.; Kagami, T.; Saruki, S.;
Araki, S.; Matsuzaki, M.
SO Journal of Applied Physics (1 June 2001) vol.89, no.11, pt.1-2, p.6653-5.11 refs.
Doc. No.: S0021-8979(01)38011-8
Published by: AIP
CODEN: JAPIAU ISSN: 0021-8979
Conference: Eighth Joint Magnetism and Magnetic Materials Intermag
Conference. San Antonio, TX, USA, 7-11 Jan 2001
AB In this work, a technique, gas cluster ion beam (GCIB), was introduced to smooth the bottom NiFe magnetic shield for **magnetic tunnel** junction (MTJ) read heads. The GCIB treatment can bring the surface roughness of the shield from 15 to 20 AA to around 5 AA, and the most of scratch marks can be removed. The efficiency of the GCIB process is dependent on the initial surface morphology. The MTJs grown on the magnetic shield smoothed by the GCIB show that the resistance area product RA is increased from 60 to 100 Omega mu m2 with the GCIB dose up to 1*1016 ions/cm2, arising from a smooth insulating layer, meanwhile, the **tunneling magnetoresistance** (**TMR**) is almost constant or slightly decreases. This GCIB process can also improve breakdown voltage (approximately 0.019 V per 1015 ions/cm2) of the MTJs, and slightly increase the **ferromagnetic coupling** mainly due to the change of the surface morphology. Using this technology, an RA as low as 3.5-6.5 Omega mu m2 together with a **TMR** of 14%-18% can be obtained for MTJs grown on the GCIB treated NiFe magnetic shield.
CT FERROMAGNETIC MATERIALS; ION BEAM APPLICATIONS; IRON ALLOYS; MAGNETIC HEADS; MAGNETIC MULTILAYERS; MAGNETIC SHIELDING; MAGNETORESISTIVE DEVICES; NICKEL ALLOYS; ROUGH SURFACES; **SURFACE TOPOGRAPHY**; TUNNELLING
ST **magnetic tunnel junctions**; magnetic shield; gas cluster ion beam; NiFe magnetic shield; read heads; surface roughness; surface morphology; resistance area product; insulating layer; **tunneling magnetoresistance**; breakdown voltage; **ferromagnetic coupling**; NiFe

L11 ANSWER 27 OF 30 INSPEC (C) 2004 IEE on STN
AN 1996:5205731 INSPEC DN A9607-7570-041; B9604-3110M-008 Full-text
TI STM studies of **GMR** spin valves.
AU Misra, R.D.K.; Ha, T.; Kadmon, Y.; Powell, C.J.; Stiles, M.D.; McMichael, R.D.; Egelhoff, W.F., Jr.
SO Magnetic Ultrathin Films, Multilayers and Surfaces. Symposium
Editor(s): Marinero, E.E.; Heinrich, B.; Egelhoff, W.F., Jr.; Fert, A.; Pittsburgh, PA, USA: Mater. Res. Soc, 1995. p.373-83 of xii+553 pp. 9 refs.
AB We have investigated the surface roughness and the grain size in giant magnetoresistance (**GMR**)spin valve multilayers of the general type: FeMn/Ni80Fe20/Co/Cu/Co/Ni80Fe20 on glass and aluminium oxide substrates by scanning tunneling microscopy (STM). The two substrates give very similar results. These polycrystalline **GMR** multilayers have a tendency to exhibit larger grain size and increased roughness with increasing thickness of the metal layers. Samples deposited at a low substrate temperature (150 K) exhibit smaller grains and less roughness. Valleys between the dome-shaped individual grains are the dominant form of roughness. This roughness contributes to the **ferromagnetic**, magnetostatic **coupling** in these films, an effect termed 'orange peel' coupling by Neel. We have calculated the strength of this coupling, based on our STM images, and obtain values generally within about 20% of the experimental values. It appears likely that the **ferromagnetic coupling** generally attributed to so-called 'pinholes' in the Cu when the Cu film thickness is too small is actually 'orange peel' coupling caused by these valleys.
CT COBALT; COPPER; FERROMAGNETIC MATERIALS; GIANT MAGNETORESISTANCE; GRAIN SIZE; IRON ALLOYS; MAGNETIC MULTILAYERS; MAGNETIC PARTICLES; MAGNETOSTATIC WAVES; MANGANESE ALLOYS; METALLIC SUPERLATTICES; NICKEL ALLOYS; SCANNING TUNNELLING MICROSCOPY; **SURFACE TOPOGRAPHY**
ST orange peel coupling; surface roughness; grain size; giant magnetoresistance; spin valve multilayers; scanning tunneling microscopy; substrate temperature; magnetostatic coupling; **ferromagnetic coupling**; film thickness; 150 K; FeMn-Ni80Fe20-Co-Cu-Co-Ni80Fe20